OSMP Geology

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Geology of Open Space & Mountain Parks

With a name like Boulder, you'd expect our beautiful Open Space and Mountain Parks to sport some pretty impressive rocks. You won't be disappointed--the dramatic Flatirons rise supremely above Chautauqua Meadow, and are a vivid testimony to the incredible geologic forces of nature that have formed and sculpted the magnificent scenery. For many, the Flatirons symbolize Open Space and Mountain Parks. These large, flat rock slabs that seem to hang on the side of Green Mountain probably received their nickname from early settlers who noted their resemblance to old-fashioned irons.

The Flatirons are part of a rock unit known as the Fountain Formation. These rocks are sedimentary--that is, rocks that have been formed by broken fragments of older rock. The Fountain Formation was deposited approximately 280 million years ago, during a time geologists refer to as the Pennsylvanian Period. The sedimentary rocks that make up the Fountain Formation formed from materials that were eroded from an Ancestral Rocky Mountain Range that existed roughly 30 miles west of the Boulder area. As these mountains wore down, coarse sand and gravel was deposited in all directions, eventually hardening to rock. The Ancestral Rockies were eventually worn down completely, and the eroded material formed younger sedimentary rock layers on top of the Fountain Formation.

Graphic - Streams carried eroded sand and pebbles from the Ancestral Rockies, dumping the material in wide deposits of gravel. These debris would later become the Flatirons! Courtesy Denver Museum of Nature and Science, Ancient Denvers. Painting by Jan Vriesen.

Although they were initially laid down in relatively flat, horizontal layers, rocks that comprise the Fountain Formation and those that were later deposited on top of them have been sharply tilted by another major uplift of the Rocky Mountain region that occurred approximately 65 million years ago. Have you ever observed a drawbridge as it tilted upward to allow ships to pass? As the Rocky Mountains rose, the overlying sedimentary rocks were tilted up in much the same way. In fact, the other flank of the "drawbridge" can be seen dipping to the west on the Colorado western slope. The Maroon Bells near Aspen form a portion of the Fountain Formation's western counterpart.

A visit to Open Space and Mountain Parks is not complete without a stop at the summit of Flagstaff Mountain. While you're enjoying the view, take a moment to examine the pinkish-gray rock that is exposed in the rugged cliffs and boulders. Known as the Boulder Creek granodiorite, this rock is the oldest found in the Boulder area. Geologists have dated the rock at 1.7 billion years, when it formed deep beneath the earth's surface during an episode of ancient mountain building. Initially a molten mineral "soup", this material cooled and hardened to form what is known as igneous rock. A tremendous amount of erosion has stripped away the overlying sediments to expose this ancient mountain core.

Observant visitors may notice remnants of old quarry sites that can be seen as you hike along the Mesa, Woods Quarry, and Royal Arch Trails. These quarries were excavated around the turn of the century to obtain Lyons sandstone, a lovely salmon-colored rock that is valued for its hardness and tendency to break off in smooth, flat slabs. Photo - These footprints showed where a reptile scuttled across an ancient sand dune 250 million years ago. The dune later became part of the Lyons sandstone formation.

You will see the Lyons sandstone as flagstone sidewalks and patios throughout Colorado, as well as in buildings at the University of Colorado. The rock hardened from finely textured sediments that were deposited as the Ancestral Rocky Mountain Range continued to erode. Sand dunes and beach deposits formed here approximately 250 million years ago when Boulder was a hot, arid desert adjacent to a wide shallow sea to the east.

A huge, inland sea began to move into the Boulder area approximately 135 million years ago, and its sandy beaches hardened to form the Dakota sandstone. Look for undulating ripple marks "frozen" in the rock, a sure sign that Boulder was once coastal property. You can see this formation at Echo Rocks, and by the water tank just west of the National Center for Atmospheric Research (NCAR). The Dakota sandstone forms the first ridge that you encounter west of Boulder, and can be traced all the way from Colorado Springs north to the Wyoming border. Besides being a major source of groundwater, the Dakota has been extensively mined in Colorado for fire clay, and contains a third of the state's oil and gas deposits.

The sea remained in the Boulder area for millions of years, depositing nearly 9,000 additional feet of sediment on top of those already left behind by the erosion of the Ancestral Rockies. Most of Boulder sits on a thick layer of Pierre Shale, soft pale sediments deposited at bottom of a shallow Cretaceous ocean while dinosaurs stalked the land and plied the waves above. Sandy deposits at the edge of this ocean account for the whitish Fox Hills Sandstone which can be seen at White Rocks and near the town of Marshall.

Graphic - Pterosaurs fly over downtown Boulder while an inland ocean deposits thousands of feet of sediment. Courtesy Denver Museum of Nature and Science, Ancient Denvers. Painting by Donna Braginetz.

Finally the sea began to retreat, and the restless earth began to stir with the birth of the Laramide Rockies 65 million years ago. Forces deep within the earth pushed and pulled the crust, creating a ridge of mountains that were later eroded down. The second pulse of mountain building occurred nearly eight million years ago, creating the present Rocky Mountains, and uplifting the entire region of the western United States. Since the great regional uplift, the forces of erosion have been carving and shaping the area to its present topography.

1.5 million years ago, temperatures cooled and the Great Ice Age had begun to add the final touches to the rugged mountain landscape. Although Open Space and Mountain Parks were too low for any glaciation, our canyons received a torrential amount of running water from melting valley glaciers to the west. The pounding force of the water carved out the canyons that today dissect the Front Range, and scoured Boulder Valley into the soft underlying Pierre shale. Large deposits of sand and gravel were carried out onto the plains, and surfaces were eroded and flattened to form the mesa tops that you can see flanking the foothills. When the glaciers were gone, the savage rivers trickled away to become the creeks and streams we see today.
Our rocks are indeed good story tellers, and the Open Space and Mountain Parks geologic story is still in the making. Enjoy their beauty and grandeur, but please take nothing but pictures!

Illustrated Geology Tour for NCAR area (1.49 MB) - A detailed point by point tour along the NCAR trail telling the stories of many exposed rock layers, by Dr. Emmett Evanoff and Dr. Sue Hirschfeld.
Sedimentary Rock Layers of the Boulder area (1.38 MB) - A lovely graphic by Dr. Emmett Evanoff